

STRATIGRAPHY AND PALAEOLOGY OF THE
UPPER CRETACEOUS (SANTONIAN) BABA FORMATION
AT SÃO NICOLAU, ANGOLA

by

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With 9 figures

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ABSTRACT

The stratigraphy and palaeontology of the Baba Formation is described from west of São Nicolau in the Moçâmedes Desert. The transgressive-regressive succession is divided into a lower unit of richly fossiliferous marine limestones and fine-grained clastics, the Caniço Member (new term), and an upper unit of nearshore coarse clastics, the Bero Member. Ammonites from the Caniço Member include *Texanites*, ?*Protexanites*, *Hauericeras* (*Gardeniceras*) and *Damesites*, and serve to date both the base of the Baba Formation and a major transgressive event to the Middle Santonian. This indicates a Middle Coniacian to Lower Santonian age for basaltic lavas of the Ombe Formation.

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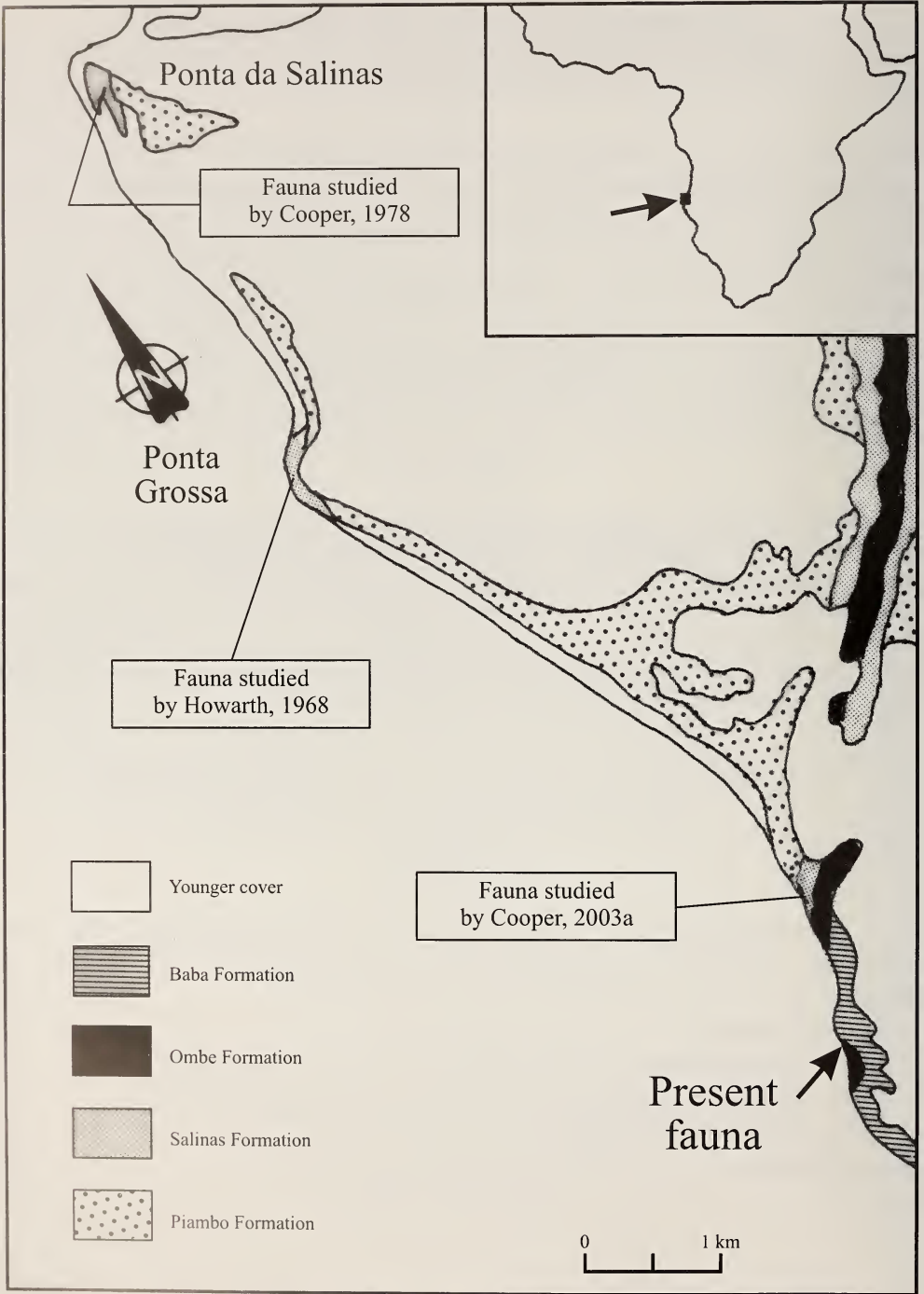


Figure 1

Locality map showing distribution of the São Nicolau Group in the vicinity of the Farol de Ponta Grossa. Adapted from Carvalho (1961).

INTRODUCTION

This paper continues the writer's account of the Cretaceous ammonite faunas and stratigraphy of Angola (Cooper 1972, 1973, 1974, 1983, 1989; Cooper & Kennedy 1979), and concerns the Baba Formation at São Nicolau (Fig. 1).

Mouta & Borges (1926) were the first to study this lithostratigraphical unit; based on occurrence of the bivalves *Crassatella numidica* Munier-Chalmas, *Cardita beaumonti* d'Archiac and *Roundaireia drui* Munier-Chalmas, they assigned a Senonian age to the Baba Formation. This age was confirmed by Rennie's (1929) study of Mollusca from the stratotype at Baba (some 60 km to the south of the present locality); identification of *Trigonarca angolensis* Rennie, *T. cf. trichinopolitensis* (Forbes), *Nemodon natalensis* (Baily), *Veniella drui* (Munier-Chalmas), *Cardita barroneti* Munier-Chalmas, *Cardium (Trachycardium) reynoldsi* Rennie, *Tellina (Palaeomoera?)* sp. and *Turritella (Haustator?) cf. acanthophora* (Müller) led Rennie (1929) to assign a Campanian–Maastrichtian age to the deposit. This determination was repeated by Mouta & O'Donnell (1933) and Mouta (1938).

Subsequent work has centred around the present exposures at São Nicolau; from here Rennie (1945) identified *Trigonia (Scabrotrigonia) shepstoni* Griesbach, *Turritella (Zaria) bonei* Baily, and *Lima (Mantellum)* sp., revising the age of the Baba Formation to Campanian. Borges (1946; cited in Carvalho 1961) listed nine molluscan species from immediately above the basalts at São Nicolau, but these identifications are suspect. Most recently, Spath (1951) identified *Eutrephoceras indicum* (Spengler) (= *E. spengleri* Wiedmann) and *Baculites aff. asper* (Morton) from collections made by O'Donnell at São Nicolau.

The lithostratigraphy of the Baba Formation in the Moçâmedes Desert was described in detail by Carvalho (1961) and this worker accepted the Campanian age ascribed these rocks. However, Cooper (1972, 1979) described the Cretaceous stratigraphy of the region around São Nicolau and Salinas and, on the basis of preliminary ammonite identifications, assigned an early Santonian age to the sediments overlying the volcanics, i.e. the Caniço Member.

STRATIGRAPHY

Cooper (1979) first applied formal lithostratigraphical nomenclature to the Cretaceous succession of the Moçâmedes desert. The Baba Formation was introduced for marine sediments which disconformably overlie the Ombe Volcanic Formation and are, in turn, overlain disconformably by the Mocuio Formation with a basal bone bed rich in vertebrate remains. The latter, which include *Mososaurus beaugei* Arambourg and selachian teeth assigned to *Squalicorax pristodontus* (Agassiz), *S. kaupi* (Agassiz), *Cretolamna biauriculata moroccana* (Arambourg), *Carcharias subulata* (Agassiz), *Rhombodus binkhorsti* Dames, *Enchodus elegans* Darteville & Casier, *E. lybicus* Quaas, *E. bursauxi* Arambourg and *E. lemonnieri* Dollo (Darteville & Casier 1941, 1946; Darteville 1942; Carvalho 1961), serve to date the Mocuio Formation to the uppermost Campanian/Maastrichtian.

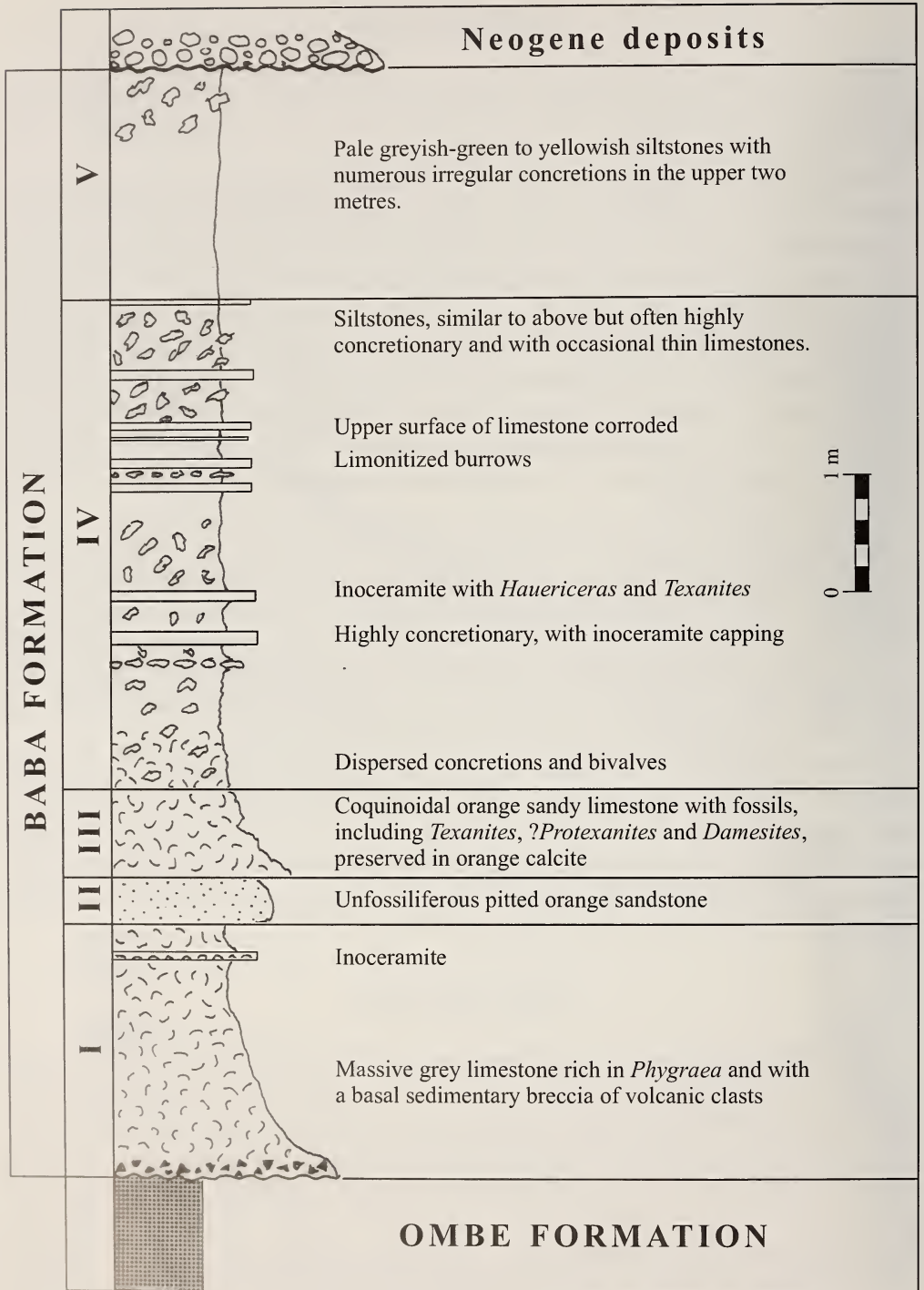


Figure 2

Measured section through the Caniço Member, Baba Formation, west of São Nicolau.

Carvalho (1961) identified a fundamental division within the Baba Formation, separating a lower unit of richly fossiliferous marine limestones and fine-grained clastics from the conformably overlying coarse clastics (with inoceramid prisms) of the Bero Conglomerate Member. This division is widespread in the Moçâmedes Desert and it is proposed here to recognize these lithological differences formally, with the introduction of the Caniço Member. The stratotype for the latter unit is in the Damba do Caniço, to the south of Chapéu Armado (cf. Carvalho 1961).

To the south-east of the Farol de Ponta Grossa (Fig. 1), the Baba Formation is represented only by the Caniço Member, which here comprises a succession of fossiliferous limestones and decalcified fine-grained clastics with concretionary horizons and layers of inoceramite (Fig. 2). These marine sediments rest disconformably on the Ombe Formation with a basal sedimentary breccia of volcanic clasts and, in turn, are disconformably overlain by Neogene conglomerates ('Tirreniano' *vide* Carvalho (1961), but probably Pliocene). Fossils, which are most abundant in the lower part of the Caniço Member, are dominated by bivalves (Figs 3–5). The collections in the South African Museum include *Neithea* (*Neithea*) *quinquecostata* (J. Sowerby), *Acanthotrigonia* sp. juv., *Veniella undata* (Conrad), *Protocardia* cf. *umkwelanensis* (Etheridge), *Trachycardium* cf. *reynoldsi* (Rennie), *Oscillopha* cf. *dichotoma* (Bayle), *Plicatula* aff. *auressensis* (Coquand) and *Phygraea* aff. *newberryi* (Stanton), with which are associated the echinoid *Bolbaster* and occasional, mostly unidentified gastropods. The ammonites described here come from units II and III of the stratigraphic column.

Because Santonian macrofossil biostratigraphy is poorly known in detail, the precise age of the succession is problematical. The association of *Texanites* + *Hauericeras* (*Gardeniceras*) immediately brackets the Caniço Member into the Santonian–Lower Campanian. Although the presence of ?*Protexanites* in unit II led Cooper (1972) to favour an early Santonian age for the Caniço Member, this ammonite genus is now known to extend into the Upper Santonian (Toshimitsu 1988).

The relative abundance of *Hauericeras* (*Gardeniceras*) *gardeni* (Baily) and *Texanites venustus* Collignon in the São Nicolau fauna is believed to be biostratigraphically meaningful since these taxa first appear only in the Middle Santonian 'Zone à *Texanites hourcqui*' of Madagascar (Besairie 1972: 285) and, likewise, are absent from the Lower Santonian of Zululand (pers. obs.). The balance of faunal evidence favours, therefore, a mid-Santonian age for the Caniço Member at São Nicolau. This determination, together with the early Coniacian age assigned to the uppermost observed levels of the Salinas Formation, serves to date Ombe volcanism as Middle Coniacian to Lower Santonian.

A mid-Santonian age for the marine transgression responsible for Baba sedimentation is of some significance, since it is of identical age to the major late Cretaceous transgressive event along the east coast of Africa (Cooper 1974, 1976), and accounts for the similarity between the Baba and Mzamba molluscan faunas (Rennie 1945; Carvalho 1961). The overlying Bero Conglomerate, a proximal shoreline facies, indicates shoaling upward and deposition of the upper Baba Formation under regressive conditions; unfortunately, the latter phase is not yet dated precisely. However, the transgressive-regressive cycle responsible for deposition of the Baba Formation is believed to correlate

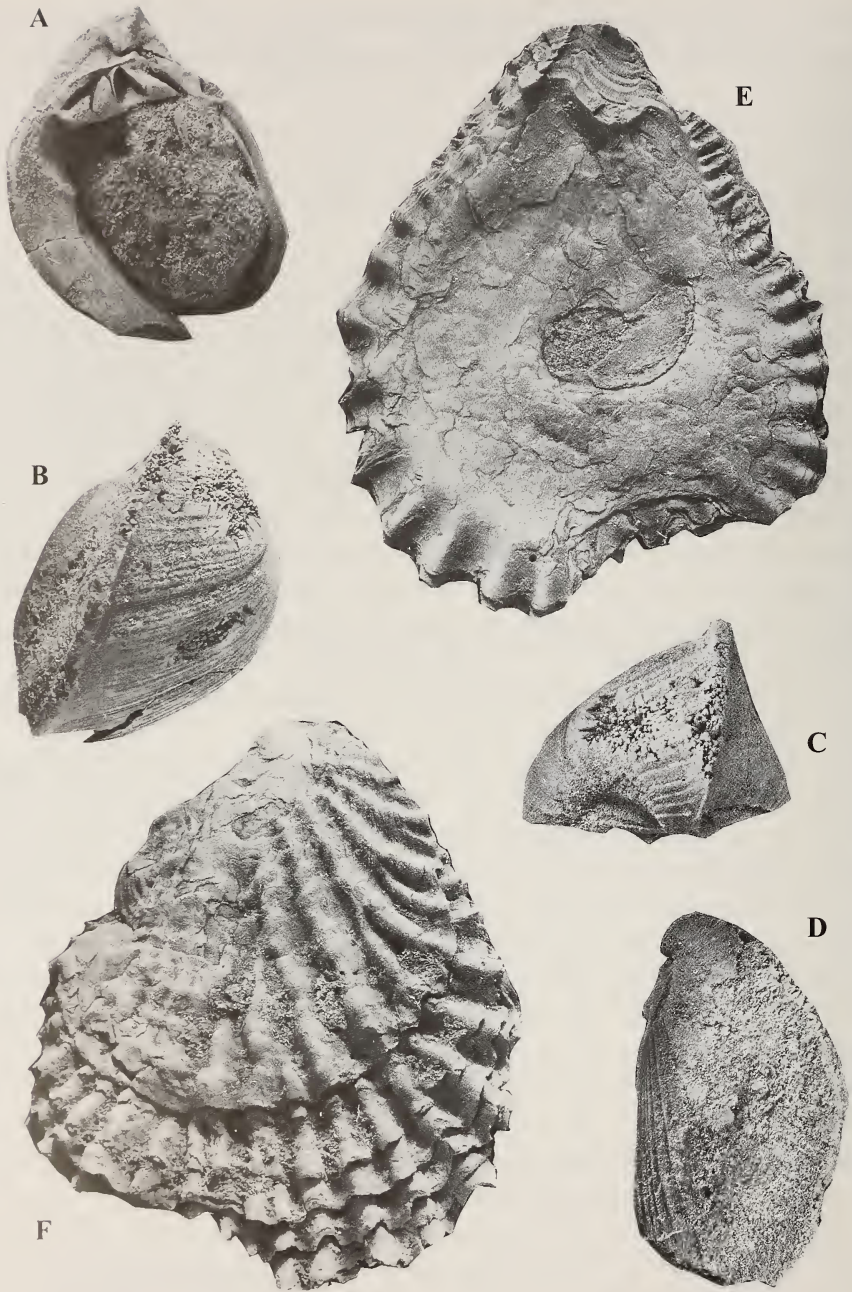


Figure 3

A-D. *Veniella undata* (Conrad). $\times 1$. Interior, lateral, dorsal and anterior views of a left valve, SAM-PCA1976. E-F. *Oscillopha cf. dichotoma* (Bayle). $\times 1$. Internal and external views of a right valve, SAM-PCA1989.

with Sequence 32 of the global sea-level curve (Haq et al. 1987).

All the material described here is housed in the South African Museum, Cape Town. Abbreviations for measurements are as follows: D = shell diameter, H = whorl height, W = whorl width, U = umbilical diameter, *c.* = circa, applies to measurements which have been estimated, whether due to erosion, damage or distortion; all measurements are followed, in parentheses, by the dimension as a ratio of the shell diameter.

SYSTEMATIC PALAEOLOGY

Subclass AMMONOIDEA Zittel, 1884

Order AMMONITIDA Agassiz, 1847

Suborder TURRILITINA Besnosov & Mikhailova, 1983

Superfamily BACULITACEAE Gill, 1871

Family **Baculitidae** Gill, 1871

Genus *Baculites* Lamarck, 1799

Type species

Baculites vertebralis Lamarck, 1799; by the subsequent designation of Meek, 1876.

Baculites aff. *bailyi* (Woods, 1906)

Compare

1906 *Baculites bailyi* Woods, p. 341, pl. 44 (fig. 5).

1951 *Baculites* aff. *asper* (Morton); Spath, 1951: 127.

Material

Three very small fragments, SAM-PCA2042, 2045-6, preserved as internal moulds.

Description

Typically baculitid, with a straight tapering shaft and compressed, elliptical whorl section. Except for some very faint undulations across the venter, ornament appears to be lacking but this may be due to erosion.

Discussion

The above material is too poorly preserved for proper identification and does not warrant figuring. However, its lack of ornament and age suggests comparison with Wood's (1906) species. As the material recorded by Spath (1951) as *Baculites* aff. *asper* (Morton) comes from the same locality it is probably conspecific.

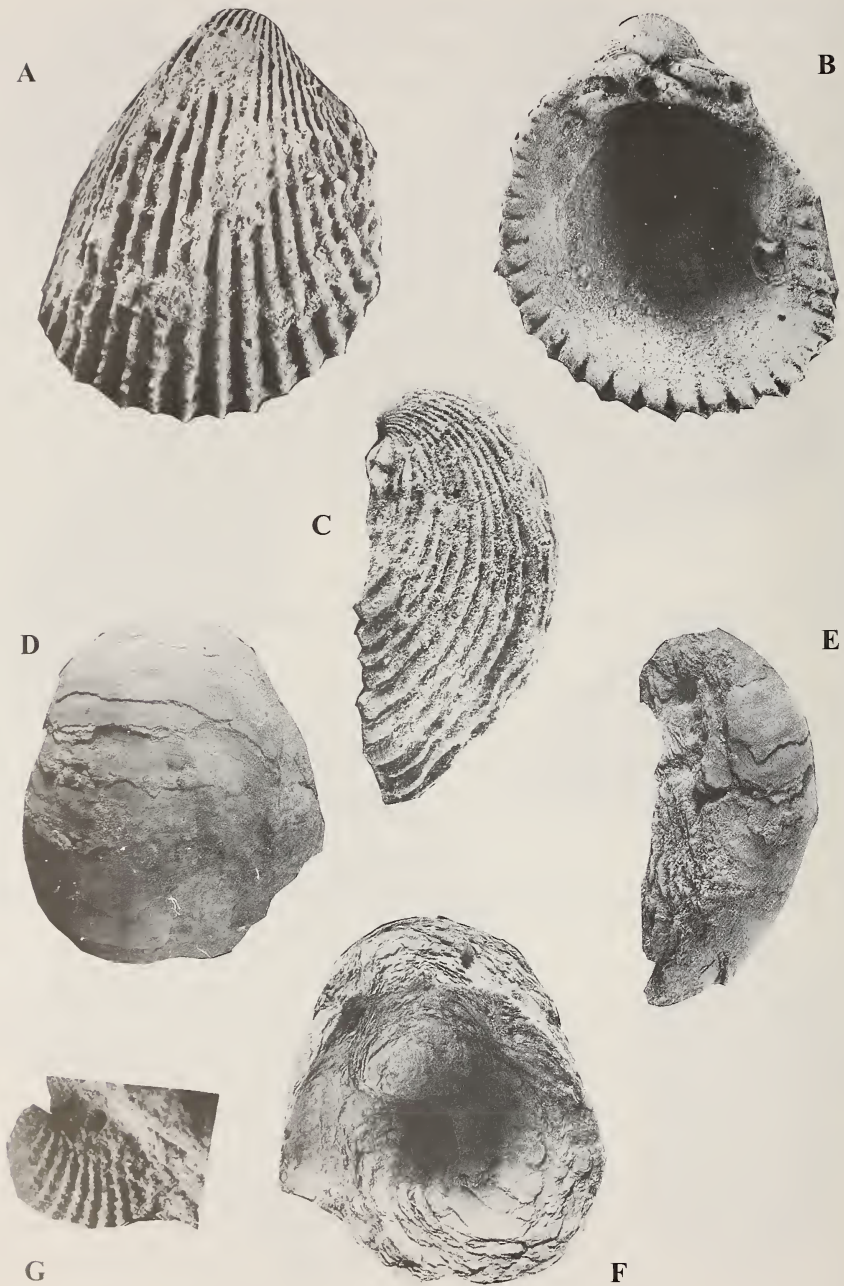


Figure 4

A-C, *Trachycardium* cf. *reynoldsi* (Rennie). $\times 2$. Lateral, interior and anterior views of a right valve, SAM-PCA1984. D-F, *Phygraea* aff. *newberryi* (Stanton). $\times 1$. Lateral, anterior and internal views of a left valve., SAM-PCA8531. G, *Acanthotrignonia* sp. juv. $\times 2$. Lateral view of a left valve, SAM-PCA3613.

Suborder HOPLITINA Spath, 1925
 Superfamily DESMOCERATACEAE Zittel, 1895
 Family **Desmoceratidae** Zittel, 1895
 Genus *Damesites* Matsumoto, 1942

Type species

Desmoceras damesi Jimbo, 1894; by original designation.

Damesites sugata (Forbes, 1846)
 Figs 6E–F, 7D

- 1846 *Ammonites sugata* Forbes, p. 113, pl. 10 (fig. 2).
 1898 *Desmoceras sugata* (Forbes); Kossmat, p. 176, pl. 18 (fig. 11), pl. 19 (fig. 1).
 1902 *Desmoceras sugatum* (Forbes); Anderson, p. 98, pl. 3 (figs 98–99).
 1954 *Damesites sugata* (Forbes); Matsumoto, p. 266.
 1955 *Damesites sugata* (Forbes); Matsumoto & Obata, p. 128, pl. 26 (figs 4–5), pl. 27 (figs 3–4).
 1957 *Damesites sugata* (Forbes); Matsumoto, p. 87.
 1958 *Kotôceras subsugatum* Anderson, p. 217, pl. 35 (fig. 2).
 1958 *Kotôceras richardsoni* Anderson, p. 217, pl. 36 (fig. 3).
 1958 *Kotôceras frazierense* Anderson, p. 217, pl. 40 (fig. 5).
 1959 *Damesites sugata* (Forbes); Matsumoto, p. 12.
 1961 *Damesites sugata* (Forbes); Collignon, p. 71 (figs 1–2).
 1970 *Damesites damesi* var. *intermedia* Jeletzky (non Matsumoto), in Muller & Jeletzky, p. 38.
 1988 *Damesites sugata* (Forbes); Toshimitsu, p. 191.
 1989 *Damesites sugata* (Forbes); Haggart, p. 195, pl. 8.4 (figs 14–23).

Material

A single specimen, SAM-PCA1968, preserving recrystallized test.

Description

The shell is compressed, extremely involute, with the outer whorl covering virtually the entire penultimate whorl. The umbilicus is very narrow (8% of the diameter) and deep, with a strongly convex umbilical wall that overhangs the seam and an evenly rounded shoulder. The broad flanks are weakly convex, with maximum width slightly above midflank, and the venter is rounded with a well-developed but narrow siphonal keel. The whorl section (Fig. 4D) is somewhat compressed, higher than wide ($H/W = 1.21$). The flanks are smooth with no sign of ornament and constrictions are lacking.

Measurements

Specimen	D	H	W	H/W	U
SAM-PCA1968	36.2	22.3 (0.60)	16.8 (0.45)	1.33	3 (0.08)

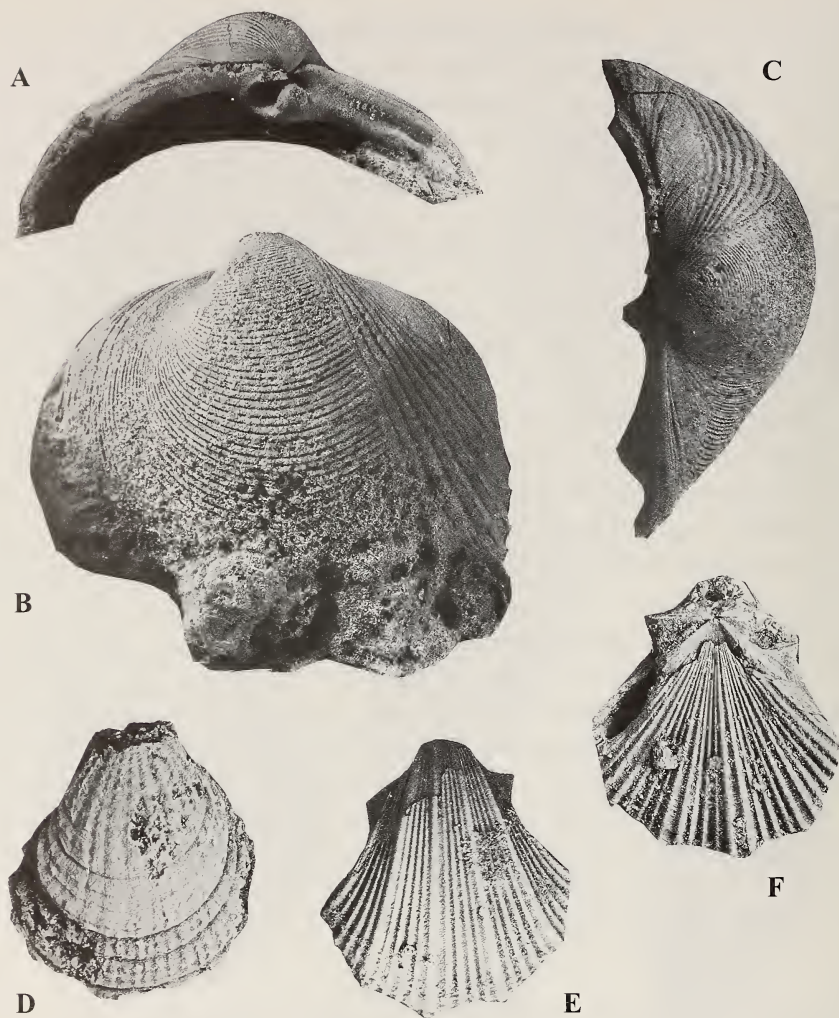


Figure 5

A–C. *Protocardia* cf. *umkwelanensis* (Etheridge). $\times 1$. Hinge, lateral and dorsal views of a left valve, SAM-PCA3613. D. *Plicatula* aff. *auressensis* (Coquand). $\times 1.5$. Lateral view of SAM-PCA1700. E–F. *Neithea* (*Neithea*) *quinquecostata* (J. Sowerby). $\times 1.5$. Lateral views of the left and right valves of SAM-PCA1705.

Discussion

The present material agrees well with Forbes' (1846) illustration and is considered conspecific. It differs from contemporaneous *D. compactus* (van Hoepen) (1921: 21, pl. 4 (figs 5–7) and Lower Campanian *Damesites rabei* Collignon (1961: 72, pl. 27 (fig. 3)) in having maximum width just above midflank and not at the ventrolateral shoulders.

Damesites damesi (Jimbo) (Matsumoto 1954: 267, pl. 5 (figs 1–3), text-figs 10–11) is a long-ranging, poorly characterized contemporary of *D. sugata*, which seems to differ only

in having flexuous constrictions. Significantly, *D. damesi intermedius* Matsumoto (1954: 270, pl. 6 (fig. 4); Matsumoto & Obata 1955: 131, pl. 27 (figs 1–2)) is claimed to be transitional between the two and Haggart (1980) suggested that this subspecies is better included in the synonymy of *D. sugata*.

Lower Santonian *Damesites tsianalokyensis* Collignon (1961: 73, pl. 27 (figs 4–6), text-fig. 11) is a Madagascan species that differs from the Angolan specimen in being more involute, with more inflated whorls and very fine flexuous lirae.

Damesites ainuanus Matsumoto (1957: 86, pl. 15 (figs 1–2)) is a Turonian–Coniacian species distinguished from *D. sugata* by its broader, lower siphonal keel. *Damesites laticarinatus* Saito & Matsumoto (1956: 192, fig. 1) from the Cenomanian of Japan has an even lower keel than *D. ainuanus*.

Damesites hetonaiensis Matsumoto (1954: 271, pl. 6 (figs 1–3), text-fig. 12) is an Upper Campanian to Maastrichtian species which was said to differ from *D. sugata* in having weaker constrictions, a narrower umbilicus, and somewhat more inflated whorls. *Damesites hetonaiensis fresnoensis* (Anderson) (1958: 218, pl. 57 (figs 1–5); Matsumoto 1959: 14) is larger than the nominate subspecies and with conspicuous flexuous lirae.

Damesites semicostatus Matsumoto (Matsumoto & Obata 1955: 133, pl. 26 (fig. 2), pl. 30 (fig. 6)) differs from *D. sugata* in possessing pronounced, weakly flexuous lirae.

Occurrence

Damesites sugata (Forbes) ranges from Coniacian to Campanian and is known from southern India (Forbes 1846; Kossmat 1895), Madagascar (Collignon 1961, 1966), Zululand (pers. obs.), California (Matsumoto 1959), British Columbia (Haggart 1989), Japan (Matsumoto & Obata 1955; Toshimitsu 1988), and now Angola.

Family **Pachydiscidae** Spath, 1922

Genus *Menuites* Spath, 1922

Type species

Ammonites menu Forbes, 1846; by original designation.

Menuites sp.

Fig. 8H–K

Material

Two specimens, the one a moderately large, highly eroded internal mould, SAM–PCA1706, and the other a juvenile preserving recrystallized test, SAM–PCA2016.

Description

The shell of SAM–PCA1706 appears to have been moderately inflated and fairly involute, with *c.* 70 per cent of the preceding whorl covered. The umbilicus is moderately wide and fairly deep, with gently sloping umbilical wall and evenly rounded umbilical shoulder. The flanks are strongly convex and converge to the evenly arched venter. The



Figure 6

A-D. *Hauericeras* (*Gardeniceras*) *gardeni* (Baily). $\times 1$. A-B. Lateral and ventral views of SAM-PCA1692. C-D. Ventral and lateral views of SAM-PCA1693. E-F. *Damesites sugata* (Forbes). $\times 1$. Ventral and lateral views of SAM-PCA1968.

only ornament is periodic prorsiradiate ribs (?constrictions), but the specimen gives the impression of having had these separated by weakly developed ribs.

The better-preserved juvenile shell, SAM-PCA2016, is compressed, moderately involute, with *c.* 60 per cent of the penultimate whorl covered. The fairly narrow umbilicus (27–31% of the diameter) is rather deep, with a steep umbilical wall and evenly rounded shoulder, and the convex flanks converge towards the narrowly arched venter. Ornament comprises prominent periodic constrictions that flex forwards slightly near the venter and, on the adoral half of the outer whorl, are separated by very weak, indistinct, flexuous riblets.

Measurements

Specimen	D	H	W	U
SAM-PCA2016	22	10 (0.45)	?	6 (0.27)
"	16	8 (0.50)	7.5 (0.47)	5 (0.31)

Discussion

The weak ornament of the Angolan material suggests it is a species of *Menuites*. However, the available material is either too poorly preserved or too immature for positive identification, and comparison with other species is unwarranted.

Occurrence

Menuites is a Campanian genus (Wright 1996).

Family **Puzosidae** Spath, 1922

Subfamily *Hauericeratinae* Matsumoto, 1938

Genus *Hauericeras* de Grossouvre, 1894

Subgenus *Gardeniceras* Matsumoto & Obata, 1955

Type species

Ammonites gardeni Baily, 1855; by original designation.

Discussion

For the most recent concepts of this genus the reader is referred to Matsumoto *et al.* (1990).

Hauericeras (*Gardeniceras*) *gardeni* (Baily, 1855)

Fig. 6A–D

1855 *Ammonites gardeni* Baily, p. 450, pl. 9 (fig. 3).

1865 *Ammonites gardeni* Baily; Stoliczka, p. 61, pl. 33 (fig. 4).

1890 *Desmoceras gardeni* (Baily); Yokoyama, p. 184, pl. 20 (fig. 10).

- 1894 *Hauericeras gardeni* (Baily); De Grossouvre, p. 219.
 1898 *Hauericeras gardeni* (Baily); Kossmat, p. 123, pl. 18 (figs 7–8, 10).
 1907 *Hauericeras gardeni* (Baily); Pervinquière, p. 166, pl. 7 (figs 1, 3–6).
 1921 *Hauericeras gardeni* (Baily); Van Hoepen, p. 27, fig. 15.
 1921 *Hauericeras gardeni* (Baily); Spath, p. 238, fig. A, 1–9.
 1931 *Hauericeras gardeni* (Baily); Basse, p. 23, pl. 4 (figs 2–4), pl. 10 (fig. 8), pl. 11 (fig. 1).
 1932 *Hauericeras gardeni* (Baily); Collignon, p. 17, pl. 3 (fig. 3).
 1952 *Hauericeras gardeni* (Baily); Usher, p. 65, pl. 5 (figs 1–2), pl. 21 (fig. 10).
 1955 *Hauericeras (Gardeniceras) gardeni* (Baily); Matsumoto & Obata, p. 140, figs 8–12.
 1961 *Hauericeras (Gardeniceras) gardeni* (Baily); Collignon, p. 76, pls 28–29, 30 (figs 1–2).
 1969 *Hauericeras (Gardeniceras) gardeni* (Baily); Collignon, p. 66, pl. 539 (fig. 2114).
 1979 *Hauericeras (Gardeniceras) gardeni* (Baily); Summesberger, p. 133, pl. 6 (fig. 27); text-fig. 19.
 1982 *Hauericeras gardeni* (Baily); Immel *et al.*, pl. 16, pl. 5 (fig. 1), pl. 6 (fig. 1), figs 2–4.
 non 1982 *Hauericeras (Gardeniceras) aff. gardeni* (Baily); Renz, p. 106, pl. 35 (figs 2–4) (= *Hauericeras (Hauericeras) sp.*).
 1987 *Hauericeras gardeni* (Baily); Immel, p. 91.
 1990 *Hauericeras (Gardeniceras) gardeni* (Baily); Matsumoto *et al.*, p. 451.

Material

Nineteen highly eroded, very fragmentary, poorly preserved specimens including SAM-PCA1692 and 1693.

Description

The shell is strongly compressed, very evolute, with a wide shallow umbilicus. The umbilical wall is steep, convex, with a subrounded shoulder, and the broad, weakly convex flanks converge to the narrowly arched, keeled venter. The whorls are strongly compressed, higher than wide ($H/W = 1.61-1.96$), with a lanceolate section. Ornament and constrictions are not preserved and the material is too poorly preserved for reliable morphometric analysis.

Discussion

Differences between *Hauericeras (Gardeniceras)* species have been covered by Matsumoto & Obata (1955) and Matsumoto *et al.* (1990), and need not be repeated here.

Occurrence

Hauericeras (Gardeniceras) gardeni (Baily) is typical of Middle Santonian to Lower Campanian strata and is reported from Austria (Summesberger 1979), Madagascar (Collignon 1961, 1966), Zululand (Kennedy & Klinger 1975), Transkei (Baily 1855; Van Hoepen 1921), Japan (Matsumoto & Obata 1955), British Columbia (Usher 1952), and now Angola.

Suborder ACANTHOCERATINA Hyatt, 1900
 Superfamily COLLIGNONICERATAEAE Wright & Wright, 1951
 Family **Texanitidae** Collignon, 1948
 Subfamily Texanitinae Collignon, 1948
 Genus *Protexanites* Matsumoto, 1955

Type species

Ammonites bourgeoisi d'Orbigny, 1842; by original designation.

?*Protexanites* sp. indet.

Material

A single whorl fragment, SAM-PCA2015, preserving recrystallized test.

Description

The shell was undoubtedly evolute, with a wide shallow umbilicus. The whorl section (Fig. 7C) is compressed ($H/W = 1.27$), elliptical in intercostal section but polygonal costally, with maximum width about a third of the way up the flank. The rectiradiate ribs begin at sharp umbilical tubercles, swell at midflank without developing a tubercle, and join prominent, swollen, clavate marginal tubercles from which they project forwards to terminate in extremely elongate external clavi. The latter are separated from the siphonal keel by narrow sulci.

Discussion

The strong ornament and trituberculate ribs of the available fragment suggest reference to *Protexanites*. Normally, the inner whorls of *Plesiotexanites* which, also, are trituberculate, do not have the very strongly clavate external tubercles of the Angolan specimen (H. C. Klinger, pers. comm. 1990).

Occurrence

Protexanites is an Upper Coniacian to Santonian genus (Wright 1957; Toshimitsu 1988), which may be present in the Middle Santonian of Angola.

Genus *Texanites* Collignon, 1948

Type species

Ammonites texanus Roemer, 1852; by original designation.

Texanites venustus Collignon, 1948
 Figs 7A–B, 8A–G, 9A

1948 *Texanites venustus* Collignon, p. 81, pl. 9 (fig. 4).

1966 *Texanites venustus* Collignon, p. 74, pl. 484 (fig. 1966).

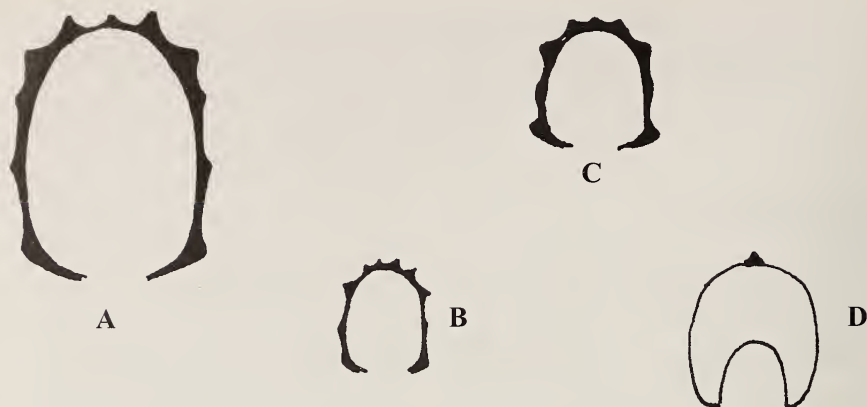


Figure 7

Whorl sections. $\times 1$. A–B. *Texanites venustus* Collignon. A = SAM–PCA1992, B = SAM–PCA1967. C. ?*Protexanites* sp., SAM–PCA2015. D. *Damesites sugata* (Forbes).

1980 *Texanites venustus* Collignon; Klinger & Kennedy, p. 124.

Material

Thirty-three specimens, the majority very fragmentary, including SAM–PCA1718, 1967, 1972–73, 1978, 1982, 1986, 1992, 1994, 1998, 2001, 2009, 2013, 2019, 2024, 2030–31, 2037, and 2048, with both recrystallized test preserved and internal moulds.

Description

The shell is strongly compressed, very evolute, with *c.* 20 per cent of the penultimate whorl covered. The umbilicus is very wide (38–47% of the shell diameter) and shallow, with a subvertical wall and evenly rounded shoulder. The whorl section (Fig. 7A–B) is compressed ($H/W = 1.09$ – 1.44), elliptical intercostally and polygonal costally, with broad, flat flanks and a narrow venter bearing a low well-developed siphonal keel. Maximum width is just below midflank. Ribs begin at the umbilical seam and pass radially outwards to prominent umbilical bullae, of which there are 22–24 per whorl. These give rise singly, or in pairs, to 38–44 strong prorsiradiate ribs per whorl; where single there is generally an associated intercalatory. On relatively large whorl fragments the majority of ribs seem to be single and slightly convex adorally across the flank, suggesting a simplification of ribbing in maturity. From the earliest stage visible flank costae are ornamented with a prominent rounded tubercle just below midflank, closely spaced marginal and submarginal clavi, and strongly clavate external tubercles. The latter are separated from the low siphonal keel by shallow sulci.



Figure 8

A–G. *Texanites venustus* Collignon. A–B. Ventral and lateral views of SAM–PCA1992. C–D. Ventral and lateral views of SAM–PCA1967. E–F $\times 1$; G $\times 2$. H–K. *Menuites* sp. juv. H–I. Ventral and lateral views of SAM–PCA2016. $\times 1$. J–K. Same. $\times 2$.

Material

Specimen	D	H	W	H/W	U
SAM-PCA2019	24	10 (0.42)	8 (0.33)	1.25	10 (0.42)
SAM-PCA2048	c. 24	9 (0.38)	7 (0.29)	1.29	c. 11 (0.46)
SAM-PCA2030	25	10 (0.40)	9(0.36)	1.11	10 (0.40)
SAM-PCA1982	31	11 (0.35)	9 (0.29)	1.22	14 (0.45)
SAM-PCA1998	32	12 (0.38)	11 (0.34)	1.09	15 (0.47)
SAM-PCA1718	36	14 (0.39)	?	?	17 (0.47)
SAM-PCA2001	c. 43	15 (0.35)	?	?	18 (0.42)
SAM-PCA1967	43	15 (0.35)	12 (0.28)	1.25	17 (0.40)
"	34	13 (0.38)	10 (0.29)	1.30	13 (0.38)
SAM-PCA1978	47	16 (0.34)	13 (0.28)	1.23	20 (0.43)
"	31	12 (0.39)	9 (0.29)	1.33	13 (0.42)
SAM-PCA1994	c. 65	23 (0.35)	18 (0.28)	1.28	c. 28 (0.43)
SAM-PCA2009	?	36	27	1.33	?
SAM-PCA1992	?	36	25	1.44	?

Discussion

The Angolan material conforms well with descriptions of the Madagascan material (Collignon 1948, 1966) and is considered to be conspecific. Other texanites to be described from Angola are *T. angolanus* Haas (1942: 12, figs 8–10), *T. angolanus berryi* Haas (1942: 15, fig. 11) and *Texanites quinquenodosus evolutus* (Haas 1942: 18, fig. 12). The former two have been included (Cooper 1989) in the synonymy of *T. roemeri* (Yabe & Shimizu) (Young 1963: 84, pl. 43 (fig. 1), characterized by coarse single ribs, and the latter taxon differs from the present species in being serpenticone (umbilicus 63% of shell diameter).

Of species that warrant comparison, *Texanites dichotomus* Collignon (1948: 80, pl. 9 (fig. 3), pl. 11 (fig. 1)) has similar ornament but typically depressed whorls (H/W = 0.83–0.91). Among the south-east African material described by Klinger & Kennedy (1980), the Angolan material is closest to highly variably *T. soutoni* (Baily, 1855: pl. 11 (fig. 1)); *Texanites soutoni natalensis* Klinger & Kennedy (1980: 214, figs 164–185) is based on much larger specimens that are difficult to compare but seem to be more evolute, with fewer (24–38) ribs per whorl. *Texanites soutoni soutoni* (Baily) (Klinger & Kennedy 1980: 189, figs 143–151, 152B, 153–163) has similar proportions but, at comparable diameters to the Angolan material, lacks bifurcating ribs. *Texanites umzambiensis* Klinger & Kennedy (1980: 167, figs 126–129, 152A) has lower whorls (whorl height only 30% of the diameter), inner whorls with prominent ventrolateral spines, and fewer, generally simple ribs per whorl.

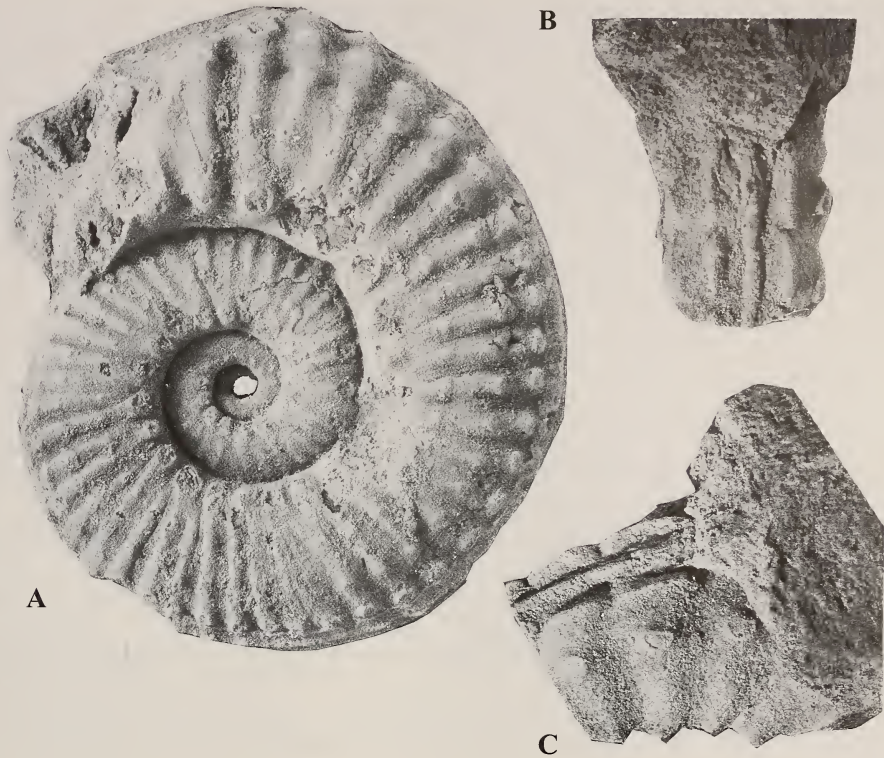


Figure 9

A. *Texanites venustus* Collignon. $\times 2$. Lateral view of SAM-PCA1967. B-C. ?*Protexanites* sp. $\times 1.5$.
Ventral and lateral views of SAM-PCA2015.

American *T. americanus* (Lasswitz) (Young 1963: 83, pl. 41 (figs 1, 3), pl. 44 (figs 2-3), pl. 48 (figs 1, 3), pl. 57 (fig. 5), text-fig 24c) has only 12-19 ribs per whorl at diameters below 50 mm, whereas very similar *T. shiloensis* Young (1963: 89, pl. 46 (figs 1-4), pl. 54 (figs 4-7), pl. 70 (figs 5-6, 8), text-fig. 24d) has only 7-8 intercalatory ribs at diameters of 40 mm or less and weaker tuberculation. *Texanites lonsdalei* Young (1963: 90, pl. 34 (fig. 1), pl. 51 (figs 3-7), pl. 58 (figs 5-6), text-fig. 22a, d) is more involute than the present species, with fewer, generally simple costae.

Occurrence

Texanites venustus Collignon is known only from the Middle Santonian of Madagascar (Collignon 1966) and now Angola.

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